

SERVERLESS PYTHON IN PRODUCTION

BUILDING SCALABLE APPLICATIONS WITH
AWS LAMBDA, CLOUDFLARE WORKERS,
AND THE **SERVERLESS FRAMEWORK**



AWS LAMBDA



**CLOUDFLARE
WORKERS**



**SERVERLESS
FRAMEWORK**



**WRITE AND TEST
PYTHON FUNCTIONS**



**DEPLOY ACROSS
MULTIPLE PLATFORMS**



**BUILD EVENT-DRIVEN
ARCHITECTURES**



**SECURE, OBSERVE,
AND OPTIMIZE**



JARED NOVAK

Serverless Python in Production

Building Scalable Applications with AWS Lambda,
Cloudflare Workers, and the Serverless Framework

Steve T. Publications

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Building Scalable Applications with AWS Lambda, Cloudflare Workers, and the Serverless Framework

About this book: This book teaches you how to build, test, deploy, and operate production-grade Python applications on two of the most powerful serverless platforms available today: AWS Lambda and Cloudflare Workers. Using the Serverless Framework as your deployment tool, you will learn everything from writing your first function to architecting complex event-driven systems with comprehensive observability, security hardening, and cost optimization. Every chapter includes working code examples, real configuration files, and expert guidance drawn from production deployments. Whether you are a Python developer exploring serverless for the first time or an experienced engineer looking to master cross-platform serverless architecture, this book is your complete reference.

Introduction: The Serverless Revolution in Python

The story of serverless computing began as a reaction against the operational burden of managing servers. Developers wanted to write code and ship it without provisioning virtual machines, patching operating systems, or worrying about capacity planning. The promise was simple: you focus on your application logic, and the cloud provider handles everything else. Today, that promise is real, and Python has emerged as one of the most popular languages for serverless development.

This book is about making that promise work in production. Not in toy demos or conference talks, but in systems that handle real traffic, process real data, and keep running while you sleep. We will cover two platforms that represent the two dominant approaches to serverless computing: AWS Lambda, the original and most mature serverless compute service, and Cloudflare Workers, the edge-first platform that brings computation closer to users than ever before. We will use the Serverless Framework as our deployment tool, because it provides a consistent, declarative way to define and deploy infrastructure across both platforms.

Why This Book Exists

When I started building serverless applications in Python, I found a gap in the available resources. Most books and tutorials focused on a single platform, often AWS Lambda alone. Others treated serverless as a theoretical concept without the gritty details of production deployment: how to manage secrets, how to structure your tests, how to debug a function that times out at 2:30 AM, how to keep costs from spiraling when a retry loop goes wrong. The books that did cover production practices were often Node.js-centric, leaving Python developers to translate concepts on their own.

This book fills that gap. It is written for Python developers who want to build real systems, not just hello-world examples. Every concept is introduced from

first principles, then built up to production-grade implementations. Every code example is tested and working. Every configuration file is something you could deploy today.

Who This Book Is For

This book assumes you are comfortable with Python: you understand functions, modules, virtual environments, and pip. You do not need prior experience with serverless computing, AWS, or Cloudflare. If you have used any cloud platform before, even briefly, you will find the transition smooth. If you are completely new to the cloud, the book will still work for you, but you may want to spend extra time on the early chapters.

The book is organized so that beginners can follow along from start to finish, while experienced developers can skip ahead to the chapters most relevant to their needs. The early chapters cover fundamentals: what serverless means, how to set up your environment, and how to deploy your first function. The middle chapters dive into specific capabilities: APIs, event-driven architectures, testing, and CI/CD. The later chapters cover advanced topics: security hardening, observability, performance optimization, and production patterns.

The Two Platforms

AWS Lambda has been around since 2014 and is the most widely used serverless compute service in the world [1]. It runs your code in response to events, automatically manages the underlying infrastructure, and scales from zero to thousands of concurrent executions. Lambda integrates deeply with the rest of the AWS ecosystem: API Gateway for HTTP endpoints, DynamoDB for databases, SQS and SNS for messaging, S3 for storage, and dozens of other services. As of mid-2026, Lambda supports Python runtimes from 3.10 through 3.14 [1,2], with Python 3.9 reaching end of support on December 15, 2025 [38].

Cloudflare Workers takes a different approach. Instead of running in regional data centers, Workers execute on Cloudflare's global edge network, with code deployed to over 330 locations across 125 countries [10,11]. This means your code runs physically closer to your users, reducing latency dramatically. Workers originally supported only JavaScript and WebAssembly, but Python support arrived in open beta in April 2024, powered by Pyodide (a port of

CPython to WebAssembly) [10,12]. Cloudflare’s pricing model is also different: the free tier includes 100,000 requests per day, and the paid plan starts at \$5 per month with significantly higher limits [13].

Both platforms have strengths and weaknesses. Lambda offers deeper service integration, more mature tooling, and a wider range of features. Workers offer lower latency for globally distributed users, simpler pricing, and no egress fees. This book covers both because the best architecture often uses both: Workers at the edge for low-latency request handling, and Lambda in the cloud for heavier computation or deep AWS service integration.

The Serverless Framework

The Serverless Framework is a command-line tool that lets you define your serverless infrastructure as code using YAML configuration files [19]. Instead of clicking through web consoles or writing hundreds of lines of CloudFormation templates, you describe your functions, their triggers, and their dependencies in a single `serverless.yml` file, then deploy everything with one command.

The Serverless Framework currently supports AWS Lambda as its primary provider, with extensive features for API Gateway, DynamoDB, SQS, SNS, EventBridge, and many other AWS services. It also supports Cloudflare Workers through a community plugin [27,28]. The framework’s v4 release (generally available June 13, 2024) brought significant improvements: built-in Python dependency bundling that replaces the need for the `serverless-python-requirements` plugin [21], native TypeScript support, revamped development mode, and integration with HashiCorp Terraform and Vault [40].

How to Read This Book

Read the chapters in order if you are new to serverless computing. Each chapter builds on concepts introduced earlier, and the code examples reference patterns established in previous chapters. If you are already experienced with one platform, you can skip the introductory chapters for that platform and focus on the areas where you need more depth.

The book does not include exercises, quizzes, or end-of-chapter questions. Instead, every chapter contains complete, working code examples that you

can adapt for your own projects. The examples are designed to be practical: they solve real problems, follow best practices, and include error handling and logging from the start.

What You Will Build

Throughout the book, we will build a series of increasingly complex applications. We will start with a simple HTTP API, then add database integration, event-driven processing, authentication, and monitoring. By the end, you will have a complete understanding of how to architect, deploy, and operate a production serverless application in Python.

Let us begin.

Chapter 1: The Serverless Mindset

Before writing a single line of code or deploying to any platform, you need to understand the fundamental mental shift that serverless computing requires. Serverless is not just a different way to run your code. It is a different way to think about architecture, operations, and cost. This chapter establishes the foundation for everything that follows.

What Serverless Actually Means (and Does Not Mean)

The word “serverless” is one of the most misleading terms in cloud computing. There are absolutely servers involved. Someone is provisioning them, patching them, monitoring them, and replacing them when they fail. The “serverless” label refers only to your relationship with those servers: you do not manage them directly.

When you deploy a function to AWS Lambda or Cloudflare Workers, the platform handles:

- **Provisioning:** Allocating compute resources before your code runs
- **Scaling:** Creating new execution environments as demand increases
- **Healing:** Replacing failed execution environments automatically
- **Patching:** Keeping the underlying operating system and runtime up to date
- **Billing:** Charging you only for the resources your code actually consumes

What you are responsible for:

- **Writing correct code:** Serverless does not fix bugs
- **Managing dependencies:** Your function still needs its libraries
- **Designing for statelessness:** Each invocation may run on a different machine
- **Handling failures:** Retries, dead letter queues, and error recovery
- **Securing your application:** IAM roles, input validation, secrets management

This division of responsibility is sometimes called the shared responsibility model. The cloud provider manages the infrastructure; you manage everything above it. Understanding this boundary is the first step toward building reliable serverless applications.

The Execution Model

Both AWS Lambda and Cloudflare Workers follow a similar execution model: your code runs in response to an event. An event could be an HTTP request, a message on a queue, a file uploaded to object storage, or a timer firing. When the event arrives, the platform:

1. Allocates (or reuses) an execution environment
2. Initializes the environment if it is cold (first run after inactivity)
3. Invokes your handler function with the event data
4. Returns the result to the event source
5. Keeps the environment warm for a period of time, then releases it

This model has profound implications for how you write code. Your functions should be short-lived, stateless, and idempotent. They should not hold open database connections across invocations, write to local disk expecting persistence, or maintain in-memory caches that outlive the execution environment.

Serverless vs. Containers vs. Virtual Machines

It is helpful to understand where serverless fits in the broader landscape of cloud compute options:

Characteristic	Virtual Machines	Containers	Serverless Functions
Abstraction level	Operating system	Application runtime	Individual function
Startup time	Minutes	Seconds	Milliseconds to seconds
Minimum unit	Full VM	Container image	Function invocation
Scaling granularity	Manual or auto-scaled groups	Orchestrator (Kubernetes)	Automatic per-invocation
Idle cost	Always paying	Always paying (unless scaled to zero)	Pay only when running
Maximum execution	Unlimited	Limited by orchestrator	15 minutes (Lambda), 5 min (Workers)
State persistence	Full filesystem	Read-write layer	/tmp only (Lambda), none (Workers)
Cold start impact	None	Moderate	Significant without mitigation

Serverless is not a replacement for every workload. Long-running processes, applications with complex state management, and workloads requiring specialized hardware are better suited to virtual machines or containers. Serverless excels at event-driven processing, HTTP APIs, scheduled tasks, and data transformation pipelines.

Why Python for Serverless

Python is one of the most popular languages for serverless development, and for good reasons. The language has a massive ecosystem of libraries, excellent readability, and strong support from both AWS and Cloudflare.

The Python Ecosystem Advantage

Python's package ecosystem is unmatched for many serverless use cases. Need to process images? Pillow and OpenCV are available. Working with data? Pandas, NumPy, and SQLAlchemy handle everything from simple CSV parsing to complex database queries. Building machine learning inference endpoints? Scikit-learn, TensorFlow, and PyTorch all run on Lambda. The only constraint is the deployment package size limit.

AWS Lambda's Python runtime includes boto3 (the AWS SDK for Python) pre-installed [2], so you can interact with any AWS service without adding dependencies. This makes Python particularly convenient for AWS-centric serverless applications.

Cold Start Considerations

Python has moderate cold start performance compared to other languages. It is faster than Java and .NET but slower than Go and Node.js. A typical Python Lambda function with minimal dependencies starts in 100 to 300 milliseconds. With heavier dependencies like pandas or numpy, cold starts can exceed 2 seconds [5].

AWS addresses this with SnapStart, a feature that takes an encrypted snapshot of the initialized execution environment and reuses it for subsequent invocations [4]. SnapStart supports Python 3.12 and later [4], reducing cold start times to sub-second levels even for functions with heavy dependencies. Cloudflare Workers use memory snapshots to achieve similar results for Python Workers, with mean cold starts around 1 second [11].

Memory and Performance

Python's memory overhead is worth understanding. The CPython interpreter itself consumes approximately 40 MB of memory on a fresh Lambda execution environment. Your code and dependencies add to this baseline. When you allocate 128 MB of memory for your function, only about 80 to 85 MB is available for your application logic.

Memory allocation in Lambda is not just about storage; it also determines CPU power. AWS allocates CPU proportionally to memory: a function with 1,769 MB gets a full vCPU, while a function with 128 MB gets approximately

0.07 vCPUs [3]. This means increasing memory can improve performance for compute-intensive functions, even if they do not use the extra RAM.

AWS Lambda vs. Cloudflare Workers: A Platform Comparison

Understanding the differences between these two platforms is essential for choosing the right tool for each part of your architecture. They are not competitors in a strict sense; they solve different problems and excel in different scenarios.

Architecture and Execution

AWS Lambda runs in regional data centers. When you deploy a function to us-east-1, it executes in one of AWS's availability zones within the US East region. Your code is physically located hundreds or thousands of kilometers from most of your users, adding network latency.

Cloudflare Workers run on Cloudflare's edge network. Your code is deployed to over 330 locations worldwide, and each request is routed to the nearest edge location. This means a user in Tokyo gets their request processed in Tokyo, not in Virginia or Oregon. The latency difference can be dramatic: 5 to 20 milliseconds at the edge versus 50 to 200 milliseconds for a regional Lambda function, depending on the user's geographic distance from the region.

Runtime Environment

Lambda provides a full Linux environment with Python installed. You have access to the standard library, boto3, system utilities, and a writable /tmp directory (up to 10 GB with ephemeral storage). You can install virtually any Python package that compiles on Amazon Linux 2 or Amazon Linux 2023.

Cloudflare Workers provide a restricted environment based on the V8 JavaScript engine with Pyodide for Python support. The Python runtime is a port of CPython to WebAssembly, which means some packages that rely on system-level C extensions may not work. However, Cloudflare has been rapidly expanding package support, and common libraries like httpx, fastapi, pydantic, and langchain all work well.

Timeouts and Execution Duration

Lambda supports execution durations up to 15 minutes (900 seconds), making it suitable for longer data processing tasks. Workers have a default limit of 10 milliseconds of CPU time per invocation on the free plan, and up to 5 minutes on the paid plan. This makes Workers ideal for request-response patterns but less suitable for heavy batch processing.

Pricing Models

The pricing models reflect the different architectures:

AWS Lambda:

- \$0.20 per 1 million requests (after free tier of 1 million)
- \$0.0000166667 per GB-second of execution time
- Free tier: 1 million requests + 400,000 GB-seconds per month
- ARM/Graviton2 instances are 20 percent cheaper than x86 [3]

Cloudflare Workers:

- Free tier: 100,000 requests per day
- Paid plan: \$5/month base with 10 million requests and 30 million CPU milliseconds included
- Overages: \$0.30 per million additional requests, \$0.02 per million additional CPU milliseconds
- No egress fees for data transfer [13]

For low-traffic applications, Workers are often significantly cheaper. For high-throughput applications with longer execution times, Lambda's pricing can be more predictable. The key insight is that you do not have to choose one platform exclusively; many production architectures use both.

Feature Comparison

Feature	AWS Lambda	Cloudflare Workers
Python support	Full (3.10 through 3.14) [1,2]	Open beta (Pyodide-based) [10]
Max execution time	15 minutes	5 minutes (paid plan) [13]
Cold start mitigation	SnapStart [4], Provisioned Concurrency [34]	Memory snapshots [11], request sharding
Package size limit	250 MB zipped, 3 GB unzipped (with EFS)	~50 MB bundle limit
Concurrent executions	Unlimited (account-level quota adjustable)	Infinite (no concurrency limits)
VPC support	Yes	No (edge network only)
Local development	SAM CLI, LocalStack, serverless-offline	Wrangler/pywrangler dev mode [11]
Storage integrations	S3, DynamoDB, EFS, RDS	KV [14], D1, R2 [16], Durable Objects [15]
Event sources	20+ AWS services	HTTP, Cron [17], Queues [37], Email Workers
Custom domains	Via API Gateway/-CloudFront	Native custom domain support [18]
Global distribution	Multi-region deployment required	Automatic (330+ locations) [11]

The Serverless Framework: Philosophy and Architecture

The Serverless Framework was created in 2015 by a team that recognized a growing pain point: deploying serverless applications involved too many manual steps across multiple cloud consoles. The framework's philosophy is simple: define your infrastructure as code, deploy it with one command, and let the tool handle the complexity [19].

How It Works

At its core, the Serverless Framework reads a YAML configuration file (typically named `serverless.yml`), translates it into cloud provider-specific infrastructure definitions (CloudFormation templates for AWS, API calls for Cloudflare Workers), and deploys everything automatically. The framework manages:

- **Packaging:** Bundling your code and dependencies into deployment-ready archives
- **Infrastructure creation:** Creating Lambda functions, API Gateway endpoints, IAM roles, DynamoDB tables, and other resources
- **Deployment:** Uploading code, updating configurations, and managing rollbacks
- **State management:** Tracking deployed resources in a local `.serverless` directory

The Plugin System

One of the Serverless Framework's strongest features is its plugin system. Plugins extend the framework's capabilities by adding new commands, modifying deployment behavior, or integrating with external services. Some popular plugins include:

- `serverless-offline`: Runs your Lambda functions locally for development and testing
- `serverless-dotenv-plugin`: Loads environment variables from `.env` files
- `serverless-prune-plugin`: Automatically removes old function versions to save storage costs
- `serverless-plugin-canary-deployments`: Enables gradual traffic shifting for safer deployments

The framework's v4 release brought built-in Python dependency bundling, eliminating the need for the previously required `serverless-python-requirements` plugin. This simplifies configuration and reduces the number of external dependencies in your project.

Multi-Provider Support

While AWS Lambda is the primary provider, the Serverless Framework also supports other platforms through plugins. The Cloudflare Workers plugin (`serverless-cloudflare-workers`) allows you to deploy Workers using the same `serverless deploy` command you use for Lambda. This means you can manage both platforms from a single toolchain, even though the underlying deployment mechanisms differ.

Your First `serverless.yml`: Anatomy of a Configuration File

The heart of every Serverless Framework project is the `serverless.yml` file. Let us examine a complete example and understand each section.

```
1  # service: The name of your application
2  service: my-python-api
3
4  # frameworkVersion: Lock to a specific version for reproducibility
5  frameworkVersion: '4'
6
7  # provider: Cloud platform configuration
8  provider:
9    name: aws
10   runtime: python3.12
11   region: us-east-1
12   stage: ${opt:stage, 'dev'}
13   memorySize: 256
14   timeout: 30
15
16   # Environment variables available to all functions
17   environment:
18     APP_ENV: ${self:provider.stage}
19     LOG_LEVEL: INFO
20
21   # IAM role statements (permissions for your functions)
22   iam:
23     role:
24       statements:
25         - Effect: Allow
26           Action:
27             - logs:CreateLogGroup
28             - logs:CreateLogStream
29             - logs:PutLogEvents
```

```

30         Resource: arn:aws:logs:*:*:*
31
32     # functions: Your Lambda functions
33     functions:
34         hello:
35             handler: handlers.hello.handler
36             events:
37                 - httpApi:
38                     path: /hello
39                     method: get
40
41         greet:
42             handler: handlers.greet.handler
43             environment:
44                 GREETING_PREFIX: "Hello"
45             events:
46                 - httpApi:
47                     path: /greet/{name}
48                     method: get
49
50     # resources: Raw CloudFormation for additional infrastructure
51     resources:
52         Resources:
53             MyDynamoDBTable:
54                 Type: AWS::DynamoDB::Table
55                 Properties:
56                     TableName: ${self:service}-${self:provider.stage}-users
57                     AttributeDefinitions:
58                         - AttributeName: id
59                         AttributeType: S
60                     KeySchema:
61                         - AttributeName: id
62                         KeyType: HASH
63                     BillingMode: PAY_PER_REQUEST
64
65     # package: Deployment packaging configuration
66     package:
67         individually: true
68         exclude:
69             - node_modules/**
70             - .git/**
71             - tests/**
72         include:
73             - handlers/**
74             - requirements.txt

```

Let us break down each section:

Service: The service field is the name of your application. It is prepended to all deployed resource names, so choose something meaningful and unique

within your AWS account.

Provider: The provider block defines the cloud platform and default settings for all functions. The name specifies the provider (aws, cloudflare-workers, etc.). The runtime sets the Python version. The region determines where resources are deployed. The stage is an environment label (dev, staging, production) that helps separate deployments.

Functions: Each function represents a single Lambda function. The handler points to your Python file and function name using the format `module.function_name`. The events block defines what triggers the function. In this example, both functions are triggered by HTTP API events, which means they will be accessible via an API Gateway endpoint. See the AWS provider reference for all available configuration options [20].

Resources: This section allows you to add raw CloudFormation resources. It is how you create DynamoDB tables, SQS queues, SNS topics, and any other AWS resource that the framework does not have a dedicated configuration block for.

Package: Controls how your code is bundled for deployment. Setting `individually: true` creates separate deployment packages for each function, which speeds up deployments when only one function changes. The `exclude` and `include` lists control what files are packaged.

Variable Resolution

The Serverless Framework supports variable resolution using the `${}` syntax. This allows you to reference other values in your configuration file, environment variables, AWS SSM Parameter Store, and external files. Common patterns include:

- `${opt:stage, 'dev'}`: Use the `--stage` CLI option, defaulting to dev
- `${self:service}`: Reference the service name from earlier in the file
- `${env:DATABASE_URL}`: Read an environment variable from your shell
- `${ssm:/my-app/database-url}`: Read a parameter from AWS Systems Manager Parameter Store
- `${file(./config.yml):database.endpoint}`: Read a value from an external YAML file

Variable resolution happens at deployment time, not at runtime. This means variables are resolved once when you deploy and then baked into the CloudFormation template. For secrets that need to change without redeployment, use AWS SSM Parameter Store or Secrets Manager and read them at runtime in your code.

Common Pitfalls

When starting with the Serverless Framework, several common mistakes can cause frustration:

Forgetting to set a timeout: The default Lambda timeout is 6 seconds. Many real-world operations (database queries, API calls) take longer than this. Always set an explicit timeout appropriate for your function's workload.

Overly permissive IAM roles: It is tempting to grant `:*` permissions to make things work quickly. This creates security vulnerabilities that are hard to audit later. Follow the principle of least privilege from the start.

Not excluding development files: Without proper `exclude` rules, your deployment package may include test files, documentation, and version control history, bloating the package size and slowing deployments.

Ignoring stage separation: Deploying everything to a single stage makes it impossible to test changes before they reach production. Use stages (dev, staging, prod) from the beginning.

Summary

Serverless computing is not about eliminating servers; it is about eliminating server management. By delegating infrastructure concerns to the cloud provider, you can focus on writing code that solves business problems. Python is an excellent choice for serverless development, with strong platform support and a vast ecosystem of libraries.

AWS Lambda and Cloudflare Workers represent two complementary approaches: regional compute with deep service integration versus edge compute with global distribution. The Serverless Framework provides a consistent toolchain for deploying to both platforms, reducing the cognitive overhead of managing multiple cloud services.

In the next chapter, we will set up your local development environment and deploy your first Python function. By the end of that chapter, you will have a working serverless application running in the cloud.

Chapter 2: Setting Up Your Development Environment

This content is not available in the sample book. The book can be purchased on Leanpub at <https://leanpub.com/serverlesspythoninproduction>.

Installing Node.js and the Serverless Framework CLI

This content is not available in the sample book. The book can be purchased on Leanpub at <https://leanpub.com/serverlesspythoninproduction>.

Installing Node.js

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Installing the Serverless Framework

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Creating Your First Project

This content is not available in the sample book. The book can be purchased on Leanpub at <https://leanpub.com/serverlesspythoninproduction>.

Python Environment Management with venv and Poetry

This content is not available in the sample book. The book can be purchased on Leanpub at <https://leanpub.com/serverlesspythoninproduction>.

Using venv (Standard Library)

This content is not available in the sample book. The book can be purchased on Leanpub at <https://leanpub.com/serverlesspythoninproduction>.

Using Poetry for Dependency Management

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Using uv for Fast Dependency Resolution

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Local Development Tools

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serverless-offline

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AWS SAM CLI

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